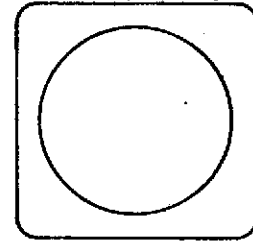


E7.4-10083  
CR 135972

# EARTH SATELLITE CORPORATION

(EarthSat)



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November 9, 1973

ERTS Program Manager  
Code ER  
NASA Headquarters  
Washington, D.C. 20546

Re: Contract No. NAS5-21795 GFSC ID ST 355

Gentlemen:

The Indiana Geological Survey and Earth Satellite Corporation (EarthSat) are pleased to submit a progress report for the period of September 1, 1973 to November 1, 1973. To facilitate, for review by NASA, a consistent summary format has been adopted for month-to-month reporting.

- A. TITLE: Study of Application of ERTS-A Imagery to Fracture-Related Mine Safety Hazards in the Coal Mining Industry.
- B. PRINCIPAL INVESTIGATOR: Dr. Charles E. Wier (SR #325)
- C. CO-PRINCIPAL INVESTIGATOR: Dr. Frank J. Wobber
- D. PRINCIPAL CONTRIBUTORS: Dr. Charles E. Wier  
Dr. Frank J. Wobber  
Mr. Orville R. Russell  
Mr. Roger V. Amato  
Mr. Thomas Leshendok
- E. SUMMARY OF ACCOMPLISHMENTS:
- ERTS imagery analysis has continued during this reporting period. Analysis of various aircraft imagery has been completed and final drafting of fracture maps of the Indiana portion of the Eastern Interior Coal Basin has commenced. These maps which present an integrated compilation of fracture data derived from ERTS and aircraft imagery and from ground measurements will make fracture data in many areas of southwestern Indiana available for the first time. They will be a significant result of the ERTS project for years to come.

E74-10083) STUDY OF APPLICATION OF  
ERTS-A IMAGERY TO FRACTURE-RELATED MINE  
SAFETY HAZARDS IN THE COAL MINING  
INDUSTRY Progress (Indiana Geological  
Survey) 9 p HC \$3.00 CSCI 08I

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- Detailed mine hazards maps for five (5) selected mine sites have been completed; additional data from forthcoming ERTS overpasses will be added.
- The utility of ERTS imagery for manual discrimination of surface mined land revegetation was tested in the Piedmont Lake area in Ohio; an area in which EarthSat analysts had no prior information. Estimated percentages of revegetation determined from ERTS alone were subsequently checked in the field and found to be reasonably accurate. From ERTS imagery acquired late in the growing season, vegetal cover classifications can be made in 25% categories using manual analysis procedures.

F. SIGNIFICANT RESULTS:

- The Mined Land Inventory map of Pike, Gibson and Warrick Counties, Indiana prepared from ERTS imagery (in July 1972 - January 1973. Type II report) was included in the 1973 Annual Report of the President's Council on Environmental Quality as an example of ERTS applications to mined lands.
- Increasing numbers of inquiries have been received from coal producing states and coal companies interested in the Indiana Program.

G. RECOMMENDATIONS FOR TECHNICAL CHANGES:

Various coal resources and environmental problems which can demonstrate ERTS contributions are being discussed with the Technical and Scientific Monitor. These are summarized as follows:

- A practical demonstration of predictive mine safety techniques is needed to facilitate industry acceptance and technology transfer to other states. Work to date is very encouraging, but data from active underground mines other than those in Indiana must be acquired to prove the technique conclusively.

Underground coal mining operations throughout the nation are critical to a balanced national energy supply. Localized, detailed testing in a series of operating mines and with the cooperation of the mine operators is required to realize an operational mining hazards prediction technique. The industry is conservative, but will adopt such procedures once they are demonstrated.

- Mine subsidence mapping and the integration of ERTS/aircraft fracture data into a predictive procedure of subsidence hazards in Indiana would increase the confidence of zoning decision at various administrative levels. Work to date has demonstrated that areas prone to subsidence can be identified using ERTS/aircraft data, but additional studies of the relation of fracture systems and floodplains to subsidence are needed.

- ERTS imagery is of unique value for mapping of certain fractures not identifiable from any aircraft imagery. Such fractures have been mapped in the test area and observed in other states (primarily Illinois) adjacent to the test area. A striking demonstration of value to several states which would be of economic value in mineral exploration and petroleum exploration and development would be an ERTS fracture map of the Illinois Basin which incorporates portions of Illinois, Indiana and Kentucky.

H. PROBLEMS:

Generally none. A problem related to firmly establishing the value of the methodology of mine hazards prediction must be tested in cooperation with coal companies. (See G above).

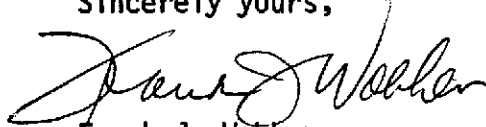
I. CHANGES TO STANDING ORDER FORMS:

None.

J. OVERVIEW OF INVESTIGATION

Fracture mapping of the project area is largely completed - pending receipt and analysis of final ERTS imagery. Mine hazards mapping procedures have been successfully tested and are being applied to the five (5) detailed mine test sites. The final report is being prepared as the project progresses. The value and significance of the program has increased with the energy crisis.

Sincerely yours,



Frank J. Wobber  
Director  
Geosciences & Environmental  
Applications Division

FJW/bcc



Charles E. Wier  
Principal Investigator

# TASK STATUS REPORT

Contract # NAS5-21795

 = Completed Tasks

TASK	STATUS	COMMENTS
PHASE II FIRST LOOK ANALYSIS		
1.0 RECONNAISSANCE ANALYSIS OF ERTS-1 IMAGERY		
1.1 PREPARE ERTS BASE MAP	COMPLETE	An ERTS Imagery photo-base map has been prepared at a scale of 1:250,000 for the area corresponding to the Vincennes, Indiana 1:250,000 scale topographic sheet. A National Mined Lands map prototype was prepared using the base map. Others maps are being prepared as suitable (cloud free) imagery becomes available.
1.2 ANNOTATE BASE MAP WITH HAZARDS DATA	COMPLETE	Various data relating to coal mining hazards have been compiled on a base map. These data include incidents of rooffalls resulting in miner deaths, and evidence of changing mine drifts indicative of weak roof.
1.3 PRELIMINARY ERTS-1 IMAGERY ANALYSIS	COMPLETE	ERTS-1 imagery has been analyzed for fracture lineaments. This will be a continuing effort. A fracture validation system (see Task 2.0, continuing data analysis) has been adopted.
1.4 RANK ERTS-1 SPECTRAL BANDS	COMPLETE	The utility of individual spectral bands for mine hazards investigations has been established by EarthSat based on imagery during the summer season and good fall coverage. This assessment will continue throughout the year. NOTE: Based on imagery to date, MSS Bands 5 and 7 appear to be most useful for fracture discrimination purposes.

TASK	STATUS	COMMENTS	
PHASE II (Cont'd)			
2.0	PRELIMINARY COMPARISON OF ERTS-1 LINEAMENTS AND KNOWN HAZARDS DATA	COMPLETE	Within the Indiana coal field the greater quantity of lineaments identified on ERTS imagery occur north of Terre Haute. A test site has been selected for special study in Parke County where underground mining is present. Kings Station Mine was studied.
3.0	INITIAL TESTING OF FRACTURE ANALYSIS TECHNIQUES	COMPLETE	Various image enhancement procedures have been tested for application to fracture analysis, and the results have been summarized for the Final Report.
3.1	MANUAL ANALYSIS	COMPLETE	The various standard manual analysis techniques apply equally well to ERTS imagery as to aerial photography. Scan line traces tend to obscure lineaments parallel to traces. Both ERTS-1 imagery and small scale photography were applied to mapping geological lineaments.
3.2	FILM SANDWICH	COMPLETE	Standard film sandwich edge enhancement techniques have not been used extensively due to quality of ERTS negatives and due to availability of electro-optical instrumentation which accomplishes same results.
3.3	COMPUTER- ASSISTED	UNDERWAY	Fracture trace angle measurement and rosette plotting by computer are being programmed. The extent of experimental processing to be conducted will depend upon available funds.
3.4	OPTICAL/ ELECTRO- OPTICAL	COMPLETE	Additive color and density slicing techniques are being used as required.

TASK	STATUS	COMMENTS
PHASE II (Cont'd.)		
4.0 / / / / /	GENERAL ANALYSIS OF NASA AIR-CRAFT IMAGERY	COMPLETE  First analysis of the 1:120,000 scale color infrared (corn blight) photography as a complement to ERTS-1 imagery has been completed. Fracture lineaments were identified in selected study areas using a validation system.
5.0 / / / / /	TEST ERTS-1/ AIRCRAFT IMAGERY TO PROBLEMS OF MINING AND ENVIRONMENT	COMPLETE  Mined land (environmental) information is available from ERTS imagery. The extent of surface mining activity, resultant water bodies, large refuse piles and slurry ponds are being identified. An updated inventory of mined lands was completed by IGS and EarthSat.
6.0 / / / / /	PREPARE AND SUBMIT DATA ANALYSIS PLAN	COMPLETE  Submitted and approved.

TASK	STATUS	COMMENTS
PHASE III CONTINUING DATA ANALYSIS		
1.0	COMPLETE	National prototype for mined land inventory has been prepared (Vincennes Quadrangle, Indiana).
2.0	COMPLETE	The preliminary validation system has been revised and is being applied to all imagery analysis
3.0	COMPLETE	High altitude (1:120,000 scale) aerial photography and all ERTS-imagery have been analyzed. Analysis of photography from NASA Aircraft Mission No. 210 and 230 plus U-2 Flight No. 73-008 is completed.
4.0	COMPLETE	The consolidation of fracture data (reduce overlays, etc. to common base) is completed.
5.0	COMPLETE	Attention is being given to the Thunderbird Mine in Sullivan County where considerable fault and roof fall data has been assembled by the Principal Investigator. The Kings Station Mine has been examined and an underground visit made to collect data.
6.0	COMPLETE	Several potentially hazardous areas were predicted in the Kings Station Mine preliminary to a mine visit. A visit to the mine showed good correlation.

TASK	STATUS	COMMENTS	
PHASE III (Cont'd)			
6.1	ESTABLISH CRITERIA FOR DETERMINING HAZARDOUS ZONES	COMPLETE	Areas of numerous joint intersections and high density of fractures have been established as the criteria for high hazard zones.
6.2	PREPARE MAP OF EVALUATION OF HAZARDOUS ZONES	UNDERWAY	Five (5) test mine areas have been selected for detailed fracture analysis and mapping at a scale of 1:24,000.
7.0	DEVELOP PROTOTYPE MINE SAFETY INFORMATION NETWORK	UNDERWAY	
7.1	VISIT MINE OPERATORS DISCUSS APPLICATIONS OF HAZARDS DATA	COMPLETE	All of the underground mining companies active in Indiana have been visited and the problems discussed.
7.2	ESTABLISH FORMAT FOR MINE SAFETY DATA DISTRIBUTION		
7.3	DISTRIBUTE MINE HAZARDS MAP		



TASK	STATUS	COMMENTS
PHASE III (Cont'd.)		
8.0	PREPARE FINAL REPORT AND TECHNICAL BRIEFS	UNDERWAY  Final report being prepared as study proceeds. Revised final report outline completed.
9.0	PREPARE COAL INDUSTRY TECHNICAL SEMINAR PROGRAM	UNDERWAY  Early and very preliminary contacts made with industry representation. A seminar program is being prepared.